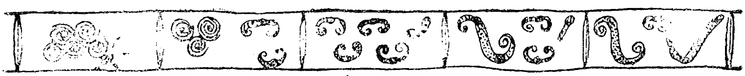
Spirogyra under shock.

STANLEY COULTER.

At the December meeting of the Indiana Academy of Science I presented a paper showing a peculiar action of the young chlorophyll band of *Spirogyra quinina* Kütz. under shock, which indicated its extreme sensitiveness and very considerable tension. The question arose as to whether this action was constant, or merely the result of peculiar conditions. If the latter, what were those conditions?

The observations upon which the conclusions of the paper were based were briefly as follows:

Certain vigorous vegetative filaments, being cut with a scalpel for the purpose of reducing their length, showed that the chlorophyll band was broken up in the cells adjacent to the cut. This breaking up seemed to have followed a somewhat definite plan. In the cells immediately adjoining the cut the band was broken into twice as many parts as there were turns of the band, and these parts were coiled closely



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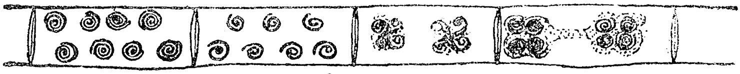
about a darker colored center, which appeared in no wise different from the nodules. As the distance from the laceration increased the closeness of the coil diminished, but the number of parts was still double the number of turns in the cell. Still further from the cut, instead of the simple coil, the band on either side of the "darker spot" broke away from its surroundings, and showed a marked tendency to coil about this "dark spot" as a center. In cells still further removed from the wound, while the band was not completely broken up, it never failed to show a strong tendency on the part of certain regions of the band to gather about certain definite centers, and these centers were always twice the number of turns in the cell. However sharp the instrument, however deft the stroke, the chlorophyll band never failed to respond to the laceration through from eight to ten cells in both directions. The only peculiarities observed in the specimens examined were:

1. The band rarely, if ever, filled the entire cell length.
2. The edges of the band were entire—not "wrinkled and crenulated."

3. The band was almost entirely destitute of nodules.

4. The specimens were collected in November and December.

The fact of the parts of the band coiling, or showing a



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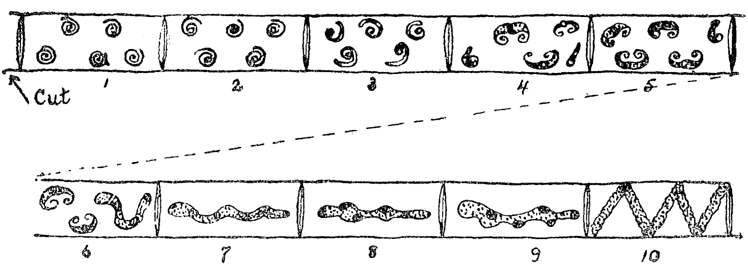
tendency to coil, about certain points suggested the possibility of these points being "centers of growth."[1] Although having very much the appearance of nodules, a careful examination seems to prove them nothing more than closely compacted, well defined masses of chlorophyll bodies. The immediate response to laceration, and the comparatively large number of cells through which the action took place, led to the conclusion that the band was extremely sensitive, while the coiling of its parts gave evidence of a very considerable degree of tension. Pressure, or other forms of mechanical violence than cutting, disintegrated the band completely, and never gave the results indicated above.

Figs. 1, 2 and 3 will, perhaps, illustrate the results more clearly than the description. The figures are drawn simply



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to illustrate the appearances, and are not drawn to any scale.

In Fig. 1 is shown the only case in which, in a series of some hundreds of slides, the nucleus was seen after the band was broken up.

Fig. 2 gives a case in which there were four turns of the band to the cell, and also shows a peculiar condition in cells 3 and 4, in which the protoplasm is gathered about the coils as indicated by the lighter shading, and seems to bind them together.

[1]Cf. Sachs, 2d Eng. ed., p. 48.

Fig. 3 shows a series of ten cells immediately adjoining the cut, and illustrates fairly well all the points indicated above. In all the figures the cut is at the left, and the darker shading represents the apparent centers.

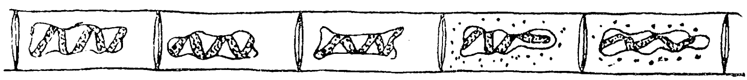
A series of experiments made in January and February verified the results upon which the paper was based. The effect of other shocks was then tried, with the following results:

Filaments plunged into boiling water showed a large distension of the cell, accompanied by disintegration and diffusion of the band; a result presumably caused by the expansion of the cell contents by the heat, although possibly the water may have penetrated the cell walls.

Filaments were then frozen in water by an improvised ice-cream freezer, and were kept packed in ice for twenty-four hours. No change was shown, if we except the evident checking of all vegetative processes. It is possible that a greater degree of cold might have produced different results.

Filaments were also subjected to an electric shock; but in every case, even with the feeblest current I was able to secure, the result was the utter destruction of the filament.

Filaments were then subjected to the action of various dilute acids. In all these cases the entire protoplasmic contents of the cell were contracted, involving, of course, the band. Brine gave similar results. In none of the cases was there even an approach to the forms shown above except in the case of brine, which, when very strong, would sometimes give forms resembling those shown in cells 7, 8 and 9 of Fig.



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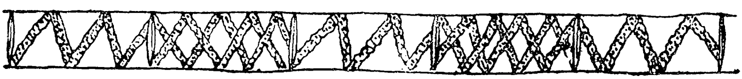
3. [See Fig. 4, which shows general action of acids and brine.]

At the close of these experiments the cause of this action was still problematical. In March, however, the pond from which all my Spirogyra had been collected failed to honor my demands. Zygnema had taken its place completely, and I was at a loss for further material. Some unused portions of previous collections had been thrown into a tub, and in this tub was found a new supply. These filaments, though evidently Spirogyra quinina, surprised me by failing to respond to laceration as readily and uniformly as I could wish. The band was more wrinkled, abounded in nodules, and

uniformly stretched from end to end of the cell. Thinking I had not secured growing tips, I cultivated a small lot in a jar; but even then, while the results were occasionally satisfactory, they were far from constant, and were secured only after a laceration that would have completely disintegrated the band in my first experiments. Material collected from other places also failed to produce the results expected. This pointed to some special local condition as the cause of the peculiar action of the band. Investigation showed the following facts:

The pond was formed by the waste water of a blast furnace. Its water was always warm. Its sandy bottom was warmer than the water. In the coldest weather it never froze. (This last fact is given upon the authority of employés of the furnace.) Thermometric tests showed that when the temperature of the air was from 16° to 20° F. that of the water of the pond was from 68° to 76° F., while that of the bottom was from four to seven degrees higher still. The



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fact that there was no time during the winter in which I was not able to collect Spirogyra or allied forms, and the collection of Zannichellia palustris, var. pedunculata, in full fruit in March [ante, p. 109], lead me to a ready belief of the statement that it never freezes.

This comparatively high and even temperature seemed, then, to be the lacking condition in the environment of the filaments grown in the tub. After numerous trials, I succeeded, by the use of a series of water baths, in securing a temperature of from 70° to 90° F. which was reasonably constant. I then cultivated some of my "unresponsive" Spirogyra with this added condition. It grew with astonishing rapidity. Examining the filaments thus grown, I found the exact conditions noted in those collected from the blast furnace pond, and a repetition of the experiments produced the same results.

The sensitiveness and tension of the young chlorophyll band noted in the paper read before the Academy may therefore, I think, be safely attributed to the influence of a comparatively high and constant temperature. The uniform results obtained in numerous repetitions of these experiments

lead me to the conclusion that this peculiar action will always be found under the above conditions.

A further fact observed during these studies may here be noted, though not connected with the main point of this article. In many cases one or more cells in a filament may be found with two bands, while the cells on either side have only a single band (Fig. 5). The frequency of occurrence of this condition would seem to indicate that the "number of bands" in a cell is an unreliable specific character.

Notes on Umbelliferæ of E. United States. VI.

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(WITH PLATE IX.)

PIMPINELLA Linn.—Fruit oblong to ovate, flattened laterally: carpel with 5 equal slender primary ribs (sometimes almost obsolete): oil-ducts 2-6 in the intervals, 4-8 on the commissural side: seed-section somewhat dorsally flattened, the face from slightly convex to more or less concave: stylopodium cushion-like or conical (figs. 69–74).—Glabrous perennials, with ternately or pinnately compound leaves, involucre and involucels scanty or none, and white or yellow flowers.[1]

1. **P. integerrima** Benth. & Hook. Gen. Pl. i. 894. Glaucous, 1-3 feet high, branching: leaves 2 to 3-ternately compound; leaflets lanceolate to ovate, entire: flowers yellow: fruit broadly oblong, 2 lines long; oil-ducts mostly 3 in the intervals, 4 on the commissural side: seed-face almost flat:

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[1] Our two western species are:

P. apiodora Gray, of the Pacific slope, from Northern California and Nevada to Oregon, of which no good fruit has been collected, and the very distinct new species from Southern California,

P. Parishii Smooth, erect, 1-2 ft. high, from a deep-seated fleshy root: radical and lower cauline leaves ternate, on petioles 2–4 in. long; leaflets linear-lanceolate, entire, 1-3 in. long, upper leaflet more or less distant; upper cauline leaves gradually reduced to bracts: peduncles 2–6 in. long; rays 8-10, glabrous; involucre of one or two bracts, or wanting; involucels of 2–6 linear bractlets: flowers white or pinkish: calyx-teeth prominent: fruit ovate to oblong, 1½–2 lines long; carpel with 5 slightly prominent equal ribs; oil-ducts 2–4 in the intervals, 6 on the commissural side: seed-face more or less concave: purple styles recurved in fruit, with conical stylopodia (figs. 73, 74).—Damp meadows, Bear Valley, San Bernardino Mts., California, August, 1882, *S. B. & W. F. Parish*. This is 987 Parish in part, and was detected in Mr. Martindale's collection. The original specimens under this number were collected in the San Jacinto Mts., in June, 1881, and were distributed as *Carum Gairdneri* Benth. & Hook., but are probably *C. Kelloggii* Gray. In 1882 specimens were collected in Bear Valley, San Bernardino Mts., and referred to the same number, and so distributed. All of this latter collection is the very distinct new species described above. Mr. Parish writes that the species is very abundant in Bear Valley, but is quite inaccessible, and that his specimens of it have mostly been distributed among European herbaria.